

solids *Pneumatic Conveying Systems* –
the most advantageous system for every product
and every task

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History

In 1970 H.J. Linder's German patent DE-PS 2-122858 described a complete procedure for pneumatical plug conveying for the first time. It features an impulse valve which forms plugs and a secondary feed line with so called relay stations to maintain the plugs and continue their transport without dispersing them.

The innovative and key characteristics were and still are

- virtually infinite conveying methods and capacities
- no blockage at slow speeds and large loading (μ = kg material/kg air, gas)
- slow, gentle conveying from approximately 0,5 m/sec
- almost nonwearing - even for extremely firm and abrasive bulk cargo e.g. silicon carbide or grinding material
- hardly any grain destruction and minimal abrasion of supersensitive products e.g. spray granulate
- no decomposition with mixtures and processed masses
- low energy costs due to an efficient use of the pressure energy

reliable operating procedures even with damp, cohesive, sticky or poorly flowing bulk goods

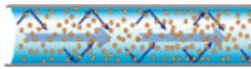
For about 40 years the **solids solutions group** has planned and built over 1000 systems based on this patent for thousands of different products in all European countries, the USA, Japan and India.

Topicality

Today the **solids solutions group** offers nine well-engineered and tested systems using components assembled by the company for the pressure- and vacuum-conveying.

With 45 engineers and technicians as well as highly trained staff in assembly, installation and service we are objectively able to offer the most advantageous system for every product and every task.

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Flow mode	Description	Vacuum up to bar (abs.)	Pressure up to bar (abs.)	Granulation from - to μ m (mm)	Velocity m/sec Beg. End.	Loading μ kg/Prod kg/Gas	Product example
solids Fly Pneu 	Dilute phase conveying classic dilute phase conveying system for suction- or pressure-conveying. Particles and particle clouds or-strands are carried by air flow.	0,5	2,5	0,0005 - 20	product 12 - 36 air 15 - 45	until about 10	flours, grain, semolina, dusts, chips, powders

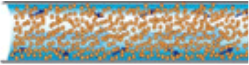
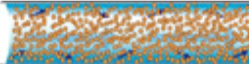

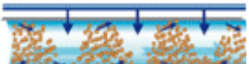

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solids Fluid Pneu 	Dense phase pressure conveying Fluidised powders are carried as homogeneous material-/air mixture using thrust.	0,2	4,0	0,01 - 1	product 3 - 15 air 5 - 20	15 - 30	cement, lime stone, flue ash, bentonite, quick lime, lime hydrate, PVC, adsorbent, powders, terephthalic acid, chalc
solids Vacu Fill 	Dense phase-vacuum batch conveying products are carried fluidised or streamed using suction power.	0,2	/	0,01 - 5	product 1 - 15 air 3 - 20	15 - 30	dusts, synthetical granulates, fibers, minerals, flours, semolina, food granulates
solids Step Pneu 	Push conveying with indicated plug formation. Grainy products with close grain spectrum are streamed and "slided" as stand or plug. The plug flow is indicated by air impulse.	/	6,0	1 - 10	product 0,5 - 10 air 1 - 15	20 - 40	sands, granulates, ash, nuts, peas, beans, activated carbon, pills, pastilles, coffee beans
solids Split Pneu 	Dense phase conveying with bypass and cones or boosters for demanding bulk solids. For avoiding blockage longer plugs are being dissolved.	/	4,0	0,001 - 1	product 3 - 15 air 5 - 20	15 - 40	Minerals, titanium dioxide, metal oxides, chalc, milk powder, pastes, PVC, dust carbon black, lead oxide, metal powder
solids Puls Pneu 	Low velocity conveying with bypass, impulse valve and relay stations. Plugs are generated and preserved and "slided" through conveyor pipes. Gentliest low velocity conveying for sensitive and abrasive products.	/	5,0	0,001 - 10	product 0,5 - 6 air 1 - 9	20 - 60	sugar, spray granulates, instant products, milk powder, carbon silicide, abradants, hard minerals, sodium percarbonate, instant coffee, adipic acid, pelletised carbon black,

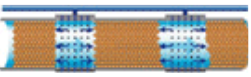
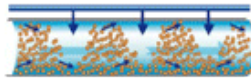
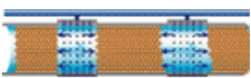
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							flakes, chips
solids Vibro Puls Pneu 	Plug conveying with bypass, impulse valve and relay stations. Non-flowing products are inserted with vibration and pressure into the conveyor pipes, plugs are generated und preserved and are slid without demixing through the conveyor pipes .	/	5,0	0,0005 - 20	product 0,5 - 10 air 1 - 15	20 - 100	damp sands, centrifugal damp solids, cohesive products, mixtures, convenience blends, dry plaster, recycling-material, sherds, carbon, coke
solids Vacu Dense 	Vacuum plug conveying with impulse valve and pressure bypass for slow and gentle suction conveying.	0,2	/	0,001 - 5	product 0,5 - 10 air 2 - 15	20 - 40	spray granulates, instant products, hard minerals, milk powder, sands, granulates, ash, legumes, flakes, chips, pelletised carbon black, adipic acid, metal powder
solids Truck Discharge 	Low velocity conveying with bypass, impulse valve and relay stations like „solids Puls Pneu“ using the silo truck as pressure vessel.	/	3,0	0,01 - 10	product 0,5 - 6 air 1 - 9	20 - 60	sugar, spray granulates, instant products, milk powder, carbon silicide, abradants, hard minerals, sodium percarbonate, instant coffee, adipic acid, pelletised carbon black, flakes, chips

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Analysis of bulk solids

First and foremost, an analysis of the bulk goods to be conveyed is required in order to choose the appropriate procedures/systems and components

Geldart divides the bulk cargos according to their fluidization behaviour and air retention into the groups A, B, C, D, providing a rough classification of the conveying characteristics

- A fine-grained powder with low density, easily fluidised with good air retention
- B medium granulation with medium density, some fluidisation properties with poor air retention
- C fine powders with higher density, cohesive, poor fluidisation properties with poor air retention
- D larger granulation with higher density, no fluidisation properties, no air retention

Jenike describes the flowability of the bulk goods using the yield function FFC, providing a rough classification of discharge behaviour from tanks. His classification is:

Freeflow	$10 \leq \text{FFC} < \infty$
Flow	$4 \leq \text{FFC} < 10$
Cohesive	$2 \leq \text{FFC} < 4$
Very cohesive	$1 \leq \text{FFC} < 2$
Non flow, hardening	$\text{FFC} < 1$

The conveying characteristics and the discharge behaviour from tanks are both relevant for the planning of pneumatical plug conveying, and therefore must be included in the evaluation.

Additionally the nature of the task and the specific requirements such as the maintenance of the product characteristics, granulation, volume, bulk weight, no contamination etc., have to be considered.

Flow charts	Product example	Description	Group acc. to Geldart	Group acc. to Jenike	solids conveying systems
	lime stone, cement, lime, PVC	easily fluidised, good air retention	Group A: fine and / or lightweight	fluidised $10 \leq \text{FFC} < \infty$ Viz. free flowing not fluidised $2 \leq \text{FFC} < 4$ viz. cohesive	solids Fly Pneu solids Fluid Pneu solids Vacu Fill
	sand, bottom ash, granulates	some fluidisation properties with poor air retention	Group B: granularity middle and / or heavy	$4 \leq \text{FFC} < 10$ viz. flowing	solids Fly Pneu solids Step Pneu solids Vacu Dense solids Vacu Dense

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	lime, titanium dioxide, metal oxides, milk powder	cohesive, no air retention, rat holes	Group C: fine and / or heavy	$2 \leq \text{FFC} < 4$ poorly flowing $1 \leq \text{FFC} < 2$ non flowing cohesive	solids Vibro Puls Pneu solids Split Pneu solids Vacu Dense
	sugar, nuts, salt, semolin, granulates, nuts, almond, frozen vegetables	crystalline up to grained, no air retention, not fluidised	Group D: coarse and / or heavy	$4 \leq \text{FFC} < 10$ viz. flowing	solids Step Pneu solids Puls Pneu solids Vacu Dense solids Truck Discharge
	convenience blends, glass raw material mixture, dry plaster with aerosol, batches, mixtures	poor air retention, fluidisation leads to demixing	Group C up to D: fine and / or heavy, coarse and / or heavy	every according to fines $2 \leq \text{FFC} < 4$ viz. cohesive up to flowing	solids Vibro Puls Pneu solids Vacu Dense solids Truck Discharge
	damp sands, mixtures, centrifugal damp solids	poor air retention, not fluidized, ductile	analogously group C: fine up to coarse and damp	$\text{FFC} < 1$ Viz. Non flowing up to hardening	solids Vibro Puls Pneu
	spray granulates, instant products, pills, pastilles, chips, percarbonate, perborate, adipic acid	sensitive products, agglomerates, poor air retention, not fluidised	Group B and D: granularity middle up to coarse and / or heavy	$4 \leq \text{FFC} < 10$ viz. flowing	solids Puls Pneu solids Vacu Dense solids Truck Discharge
	abrasive products	all products from about hardness 4 on acc. Mohs	not classified	$1 \leq \text{FFC} < 10$ depending on granularity	solids Split Pneu solids Puls Pneu solids Vacu Dense solids Truck Discharge
	lumpy recycling-material, sherds	not fluidised, no air retention	analogously group B-D	$2 \leq \text{FFC} < 4$ viz. poorly flowing	solids Fly Pneu solids Vibro Puls Pneu

»Your bulk solids.
Our solution.«

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